

CLAIMS

- 1 1. Apparatus comprising
2 a portable electronic device,
3 a digital camera associated with the portable electronic
4 device, and
5 software configured to run on the portable electronic device
6 and to derive handwriting and control information from hand
7 motion of a writing instrument in the vicinity of the digital camera.
- 1 2. The apparatus of claim 1 in which the portable electronic
2 device comprises a mobile telephone or a personal digital assistant.
- 1 3. The apparatus of claim 1 in which the digital camera is
2 attached to the portable electronic device.
- 1 4. The apparatus of claim 1 in which the digital camera is
2 incorporated in the portable electronic device.
- 1 5. The apparatus of claim 1 also including an infrared filter
2 arranged to filter light being received from the writing instrument.
- 1 6. The apparatus of claim 1 also including a lens arranged to
2 alter the focal length and/or depth of field of the digital camera.
- 1 7. The apparatus of claim 1 also including a mechanism
2 configured to enable the digital camera to be attached to a writing
3 surface.

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- 1 8. The apparatus of claim 7 in which the mechanism
2 comprises a suction device configured for attachment to a white
3 board.
- 1 9. The apparatus of claim 7 in which the mechanism
2 comprises a clip configured to grasp paper.
- 1 10. The apparatus of claim 7 in which the portable electronic
2 device includes a writing surface.
- 1 11. The apparatus of claim 10 in which the writing surface is
2 on a protective cover.
- 1 12. The apparatus of claim 1 in which the software is
2 configured to define a mapping between a sensor surface in the
3 digital camera and a space in which the hand motion is occurring.
- 1 13. The apparatus of claim 1 in which the software is
2 configured to define the mapping in response to calibration steps
3 that include a user marking three locations in the space in which
4 the hand motion is occurring.
- 1 14. The apparatus of claim 1 in which the software is
2 configured to derive the location and trajectory of the hand motion.
- 1 15. The apparatus of claim 1 in which the software is
2 configured to generate the handwriting and control information
3 based on processing cycles each associated with one location of the
4 writing instrument.
- 1 16. The apparatus of claim 1 in which the software is
2 configured to discriminate light received from the writing

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3 instrument by locking onto a carrier frequency at which light from
4 writing instrument is modulated.

1 17. The apparatus of claim 1 in which the software is
2 configured to determine a tilt of the writing instrument relative to a
3 direction normal to a writing surface.

1 18. The apparatus of claim 1 in which the portable electronic
2 device includes a display and the trajectory of the hand motion is
3 shown on the display in real-time.

1 19. The apparatus of claim 18 in which the display is not
2 touch-sensitive.

1 20. The apparatus of claim 1 in which the portable electronic
2 device includes a digital signal processing chip and a general
3 purpose microprocessor and the software is run in part on the chip
4 and in part on the microprocessor.

1 21. The apparatus of claim 1 in which the portable electronic
2 device includes a wireless communication facility and the software
3 is configured to communicate the handwriting and control
4 information to a remote location.

1 22. The apparatus of claim 1 in which the digital camera is
2 configured to receive light that has been reflected from the writing
3 instrument.

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- 1 23. The apparatus of claim 1 in which the digital camera
2 comprises a still camera.
- 1 24. The apparatus of claim 1 in which the digital camera
2 comprises a video-capable camera.
- 1 25. The apparatus of claim 1 also including an infra-red beacon
2 configured to be directed at the writing instrument.
- 1 26. The apparatus of claim 1 in which the software is
2 configured to apply pattern recognition to signals from the digital
3 camera.
- 1 27. A method comprising
2 exposing a sensor of a digital camera to a writing
3 instrument that is being subjected to hand motion, and
4 in a device associated with the digital camera, processing
5 the data to infer handwriting and/or control information based on
6 the hand motion.
- 1 28. The method of claim 27 in which the exposing of the
2 sensor includes receiving light that originates from light sources on
3 the writing instrument.
- 1 29. The method of claim 27 in which the exposing of the
2 sensor includes exposing the sensor to a trace or other marking left
3 by the writing instrument.
- 1 30. The method of claim 29 in which the trace or other marking
2 includes ink selected to increase a signal-to-noise ratio of light
3 received by the sensor.

- 1 31. The method of claim 27 in which the exposing of the
2 sensor includes processing of an image of a tip of a writing
3 instrument.
- 1 32. The method of claim 31 in which the tip of the writing
2 instrument is characterized by being of high contrast with the
3 environment in which it is used.
- 1 33. The method of claim 27 in which the sensor is exposed to
2 hand motion occurring with respect to any arbitrary surface at any
3 arbitrary angle.
- 1 34. The method of claim 27 also including
2 calibrating the digital camera in a manner to permit
3 correctly inferring linear hand motions.
- 1 35. The method of claim 27 also including calibrating the
2 processing of data using information derived when the writing
3 instrument is touched to at least two points on a writing surface.
- 1 36. The method of claim 27 also including automatically
2 switching the digital camera from one format to another by
3 coupling the camera, or a device to which it is connected, to
4 another mechanism.
- 1 37. The method of claim 27 also including adjusting a tilt
2 and/or swivel position of the camera for better coverage of a
3 writing surface.
- 1 38. The method of claim 27 in which light sources on the
2 writing instrument are operated to enabling filtering of noise and
3 interference.

1 39. The method of claim 27 in which light sources on the
2 writing instrument are sequenced to encode functionality that
3 includes at least one of erasing or biometrics of handwriting.

1 40. The method of claim 27 in which there are enough light
2 sources associated with the writing instrument to prevent loss of
3 tracking when one or more of the light sources are blocked.

1 41. A method comprising
2 using a two-dimensional sensor in a digital camera to
3 permit subpixel calculations of a position of a writing instrument
4 that is in the field of view of the camera,
5 averaging lines, and
6 applying an algorithm to derive a final position from the
7 averaged lines.

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